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Why and How Should We Account for the Environment?

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Abstract:

As a guide to economic policy many countries nowadays have a system of national accounts. The basic system was developed in the post World War II period, and was the outcome of a truly international effort. Involving the United Nations and other international organizations, it has been very successful in developing an international bookkeeping system, nowadays accepted and introduced by all developed and many developing countries.

National accounts basically are compiled because policy-makers wish to have an overview of the economic performance of their country. The most well-known indicator for this is Gross Domestic Product. Other important indicators are those for industrial production, investments, consumption and the trade figures. Basically we are dealing with a system where the quantity of goods is measured in physical units valued at market prices. The rise in public sector administration has complicated matters, because of missing market prices. However, here good approximations have been developed.

A fundamental problem arose when the wish originated to include nature into this accounting system. The idea was quite clear, i.e. to lend support to policy making when natural functions are included and/or affected. However, a problem that did not go away was which properties to attribute to nature or its functions. The present paper aims to show, first, that environmental accounts are a necessary prerequisite for environmental policy, and second, to explain what kind of environmental accounting system is the most preferable one. In principle, economists have developed two different approaches to account for the environment. One approach is based on the vision that the environment should be valued in monetary terms. The other one is to relate the environment, measured in physical units, to economic variables. The question then is what kind of environmental system should the preferred one.

In a certain sense the discussions in the Netherlands concerning environmental accounting are the mirror image of the discussions which have taken place in the rest internationally. In the Netherlands, however, the discussion got a particular twist. In fact, *two* systems have been discussed and developed in statistical bureaus. In essence, the Dutch discussion reflects the discussion between the two main strands of thought. The decisive difference between both goes back to the question: "Is it possible to value natural functions in monetary units?" If yes, it is possible to calculate something like a Green National Income (GNI), which was proposed by the Dutch national accountant Roefie Hueting (1969, 1974) at first. His operationalization of the basic idea was to value all environmental damages in monetary units and then to subtract these numbers from the net national income (NNI). He

[1] First draft, please do not quote without permission of the author. I thank Bert Steenge, Bart de Boer, Mark de Haan and Roefie Hueting for helpful comments and suggestions. All errors are mine.

called this figure the Sustainable National Income (SNI). Only if the difference between NNI and SNI would be zero, the economy would be environmental sustainable. If it is not possible to value the nature in monetary terms, it is impossible to calculate a Green National Income.

During the 1990s, the Dutch national accountant Steven Keuning developed an alternative system (the National Accounting Matrix including Environmental Accounts – the so-called NAMEA system), where he related quantities of emissions measured in physical units to figures of the conventional accounting system, e.g. CO2 emissions to GDP. The question then is which system should be preferred to inform policy-makers and the public about the state of the economy concerning the environment. The paper will go into these issues, and come to a conclusion.

JEL: Q56, Q57, E01

1. Introduction

The United Nations' System of National Accounts (SNA) clearly is one of the most important economic institutions of our time in the world. The SNA was developed by Stone (1986, 1997) in the fifties of the 20th Century, building on the work of prominent precursors.[2]

The SNA nowadays is the most important resource of information for economists, economic advisory, business men, institutions and policy-makers to think about economic growth and development and it represents the empirical basis for much of their decision-making:

"The primary objective is a comprehensive accounting framework, within it economic data can be compiled and presented in a format that is designed for purposes of economic analysis, decision-taking and policy-making." (UN (1993), para 1.1).

The history of national accounting goes back to the 17th century. Sir William Petty (1691) is recorded to be one of the first who computed national income for England in 1665 as an intellectual exercise.[3] Kendrick (1972) reports that "*intellectual curiosity*" and "*nationalism*" motivated individual investigators in a few industrialized countries before the twentieth century to prepare income estimates based on fragmentary and questionable data.[4] Especially the motivation of nationalism was important for the development of national accounts. At that time national governments were especially interested into the state of the economy to estimate if the economic power was sufficient to guarantee enough (military) power to defend the country in a war and/or to attack some other country.

In 1947, after the Great Depression of the 1930ies and WW II, the United Nations' System of National Accounts (SNA) came into being with the report on the: *"Measurement of National Income and the Construction of Social Accounts",* to get a comparable basis for the

[2] The very early national accountants were Petty (1691), King (1696), de Boisguilebert (1695), Vauban (1843), Quesnay (1758), Marx (1858), and in the last century were Groman & Popov (USSR 1926), van Cleef (1941a, 1941b) and Gruenbaum (1941). During the WW II Stone worked together with Meade and Keynes on how to finance the war (1940).

[3] His aim was to show two things: Firstly, that government could raise a much larger tax revenues to its needs and secondly, that war would not ruin England. (Studenski 1961). In the view of King (1936) information of a country's wealth and population is a "piece of political knowledge", Studenski (1961).

[4] Studenski (1961), Kuznets (1972) and Campbell & Peskin (1979) give overviews of the early efforts of national accounting. Or see Bos (2003) for a more recent contribution.

most economic data. Since that time the SNA is the main source for empirical macroeconomic theory and macroeconomic policy. One reason for this development was the application of the Keynesian theory (Keynes 1936) in politics. To do that policy-makers needed the information to apply Keynes' ideas the demand-side economic policy.

In end of the sixties and the beginning seventies[5], many people realized that industrial production often is harming the environment in an irresponsible manner. Additionally they have drawn public attention by criticizing that the SNA is fundamentally misleading,[6] because environmental destruction plays no role in it. Especially, after the publication of the Brundtland-Report, it became clear that policy-makers should take into account environmental aspects. However, to make environmental policy one must have sufficient information about the state of the natural environment. In the time between 1970 and 1995 more and more approaches were developed how to account for natural resources and environmental damages. In principle, two different strands of environmental accounts were developed, on the on hand the so called "Green national income" (GNI) concepts and on the other hand "physical accounts". The Dutch economist Roefie Hueting (1974, 1980) was probably the first who developed a GNI, what he called a sustainable national income (SNI). The SNI is a representative GNI and it was discussed intensive in the Dutch policy and science. We will compare SNI with the concept of a "national accounting matrix including environmental accounts" (NAMEA), which was an alternative development, proposed by the Dutch economist Steven Keuning (1991, 1992, 1993) and his co-worker de Haan (2004) at Statistics Netherlands (CBS).[7]

The paper is organized as follows: in the second chapter we present the basic principles of national accounting in the third chapter we present the NAMEA, and in the fourth chapter we present the SNI. Then we discuss the advantages and disadvantages of these approaches. In the last chapter we conclude our results.

[5] See e.g. Club of Rome (1972).

[6] See e.g. Repetto (1989) or Waring (1990).

[7] The former name of Statistics Netherlands was Central Bureau of Statistics, but the abbreviation CBS is still in use.

2. The Basics of National Accounts[8]

The system of national accounts is a systematical, consistent and comprehensive framework to give a full quantitative description of aggregate variables of the national economy within one period (mostly a year).[9] The most important aggregate variable is the gross domestic product (GDP), which is defined as the sum of the values of all goods and services measured in money, which are produced within one year.

The system consists of a set of different calculations. There are two complementary and partly overlapping systems of frameworks: the sector accounts and the input-output framework. The sector accounts are divided up into four domestic sectors: the financial corporations, the non-financial corporations, households and government. From a political view it is interesting to look at the following processes:

1. The production (agrarian, industrial and service sectors)
2. Value added and its components
3. Allocation of primary income (wages, land rents and capital income)
4. Distribution of income (taxes, subsidies, income transfers et cetera)
5. Consumption expenditures
6. Financing
7. Changes of capital properties
8. Other Changes

To ensure that the national accounts are consistent, all transactions must be recorded twice, as an input factor and as an output. The aggregated transactions of inputs measured in monetary terms must be equal to the aggregated transactions of uses.

In principle, the national accounts consist of flows (like consumption, savings et cetera) and of stocks (like capital wealth, financial wealth et cetera.). An economic transaction in the sense of the system of national accounts is defined as a transition of goods, services or property from one economic subject to another. Subjects in this respect are persons or economic institutions (e.g. corporations, government).

To give some insight into the system of national accounts here we give some simple examples of stock and flow accounts.

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[8] This chapter is written for those that are not directly familiar with national accounts; other readers may skip this section.

[9] An extensive analysis of national accounting is given in Bos (2003).

At first we look at the simplest form of a national stock account:

Balance sheet

Assets	Debts
Financial and non-financial assets	liabilities
Debts	balance: net wealth

Figure 1

This balance sheet expresses that the national net wealth consists of financial assets like bonds, non-financial assets like capital goods and debts (monetary wealth) and of liabilities. The sum of assets and debts minus liabilities gives the net wealth of the economy:

Assets + debts – liabilities = net wealth

This is the simplest form of a stock account. Now we come to the simplest flow account. The flow accounts are based on the idea of economic circulation that means that all economic activities are organized in terms of a circulation flow. The simplest circle consists only of households and corporations:

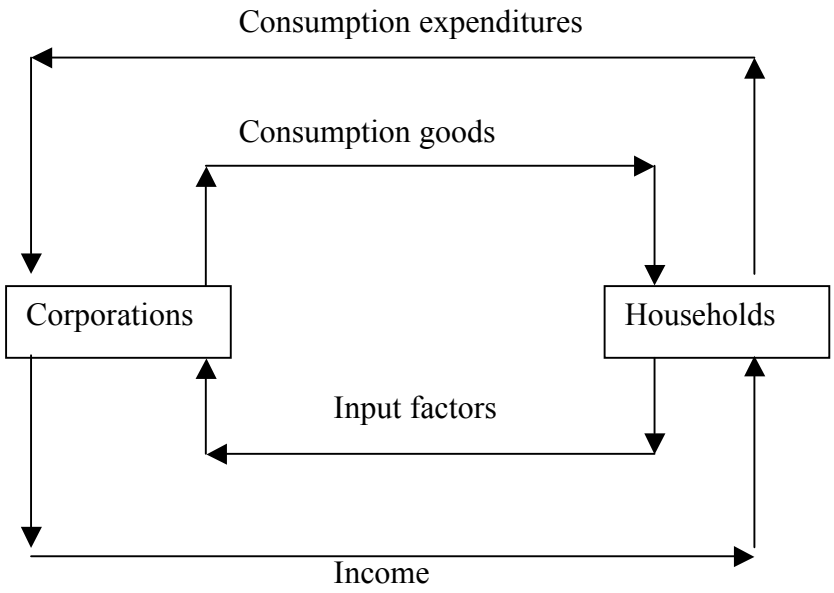

Figure 2

Figure 2 tells us that that there is a flow of input factors (resources) like capital and labor to the corporations the output consists of incomes (revenues, rents and wages), which are earned by consumers. The inner circle is closed through the flow of consumption goods from corporations to households. The outer circle consists of a flow of consumption expenditures from households to corporations and a flow of incomes (wages, interest payments et cetera) from corporations to households.

The main task of the system of national accounts is to calculate the national income and aggregate production of one period. Figure 2 makes clear that the value of the aggregate income must be equal to the aggregate consumption expenditures and equal to the value of the aggregate production and equal to the aggregate value-added of factor inputs. This is the simplest representation of the System of National Accounts.

Let us now introduce savings and wealth in this system.

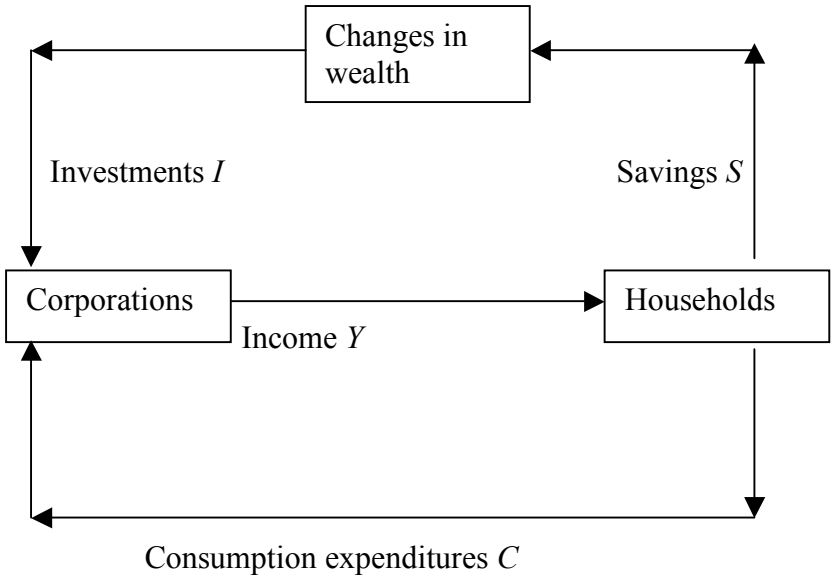

Figure 3[10]

If the expenditures and earnings of one sector are not equal, it is necessary to introduce a balance category, which considers this. This is done by the change of wealth. That means that households save a part of their income. The savings are used for investments on the one hand and on the other hand corporations have to pay an interest rate on the savings in the future. From the ex-post view the aggregate savings are always equal to the aggregate investments. This needs not be true from the ex-ante view. That implies that the planned savings can be different from the planned investments, but this is irrelevant for the system of

[10] We ignore deprecations here.

national accounts, because the system of national accounts only accounts from the ex-post view. Instead of the graphical representation, we can make use of a system of equations to represent the national accounts:

$$Y \equiv C + I$$
$$Y \equiv C + S$$
$$I \equiv S$$

Obviously, we can use two of the three equations to derive the third one. This is a tautology, implicitly; we assume a 'corn economy'. What is not consumed is invested. The first equation means that the whole income is being spent, either for consumption goods and/or services or for investments. The second equation tells us, that the income is either consumed or saved. In conclusion, we get the third equation, which means that the investments are equal to the savings.

An alternative representation of the figure is given in an accounting matrix:

From/to	Corporations	Households	Change of wealth	Aggregated
Corporations	-	Y	-	Y
Households	C	-	S	C+S
Change of wealth	I	-	-	I
Aggregated	C+I	Y	S	

Figure 4

Figure 4 shows for example, that households earn their income from corporations. A part of the income is used to buy products and services from the corporations sector. The remaining part of the income is saved and lend out to the corporations. Corporations use the savings to finance investments. In the future, corporations must pay back the loans and pay an interest on the loans to the savers. All three methods (book-keeping, mathematical representation and accounting matrix) of representing the national accounts are consistent with the principles of double-bookkeeping.

The above represents the principles of the system of the national accounts. Here we made use of a very simple economy, but it is no problem to extend these accounts with regard

to international trade, government (taxes and subsidies), financial institutions et cetera. The structure of the system of national accounts is always the same; all three methods coincide, but they are complementary in the use of national accounts.

Until here it is clear how the national accounts are constructed and organized, but we see it is unclear what the terms *'income, consumption and investments'* mean and how to measure this. It is a real problem to define these terms. Let us look at the following example. The gross national income shall represent the value of all produced goods and services of one year. Some non-economists like C.A. Miller[11] (2005, p. 416) assumes, that the GDP is *"a trusted number"*, but it is not. For example some people may believe that the work of a housewife is integrated in the GDP, but this is not correct. The reason is that there exist no market prices for homework or child rearing of housewives.[12] Moreover, because of the fact that there are no prices, the convention is accepted, that all things that have no market prices are ignored in the national accounts except the actions of the government and the public sector. The services of the public sector have clearly no market prices, but the costs of the services are known. In the national accounts, the services of the public sector are valued by the costs of supplying these services. This is a convention. Contrary, to this the costs of child rearing are not known, neither explicitly nor implicitly. Consequently it was decided, that all economic transactions, which have no (market-) prices, are ignored in the national accounts.[13] This is a convention to make it possible to compare the economic performance of different countries.[14]

This kind of GDP cannot be interpreted as a measure of the welfare of an economy, because some transactions which are welfare-enhancing are ignored, while vice versa certain expenditures increase the GDP without enhancing the welfare. An example for the latter statement is that an increasing number of car accidents causes an increase of demand for the car repairing services and that increases the expenditures for car repairing and consequently this increases the GDP without any welfare gain. This is a fact, because nobody is better off, if his car is only repaired. An additional example is the expenditures for national defense.

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[11] Miller is an American political scientist.

[12] If the work was done by a housekeeper, than the GDP would grow, because the housekeeper gets a wage for his/her work.

[13] See e.g. SNA 1993.

[14] However, we must take into account that it makes no sense to compare two identical economies, except that in the first all homework is done by housewives and that in the second all homework is done by professional housekeepers. The statistical GNP will be much higher in the second economy, although the "real" values of all goods and services in both economies are identical.

Additionally, leisure time is not a part of the national accounts, although leisure time is surely a factor of the welfare. At least, it should be noted that the conventional national accounts ignore external effects, such as the destruction of the natural environment. If we think for example of the exploitation of the forests of Brasil or Siberia, we come to the result that the exploitation increases the GDP, but it is questionable if it is really welfare enhancing. There are many more reasons why the GDP should not be used as a measure or a yardstick for the welfare of an economy. For example, Bos (2003, p. 77) concludes:

"The sector accounts are not based on one grand vision of the national economy. It is a mixture of strict bookkeeping logic, economic principles, administrative concepts and specific national accounts conventions."

Consequently, it can be concluded that the conventional system of national accounts has a broad scope including many different economic and administrative categories, but it does not measure welfare, in a well-defined sense. The system of national accounts tries to fulfill a number of requirements such as comparability, operability, and consistency to give an overview of the economic performance of an economy.

3. Introduction into Environmental Accounting

Since the environment became more and more an important part in the focus of policy-makers and the public, the demand for environmental accounting has increased. The motivation for environmental accounts has been the adoption by many governments of the notion of sustainable development and, together with the understanding that economic activities and appropriate economic incentives play a central role in determining whether development is sustainable or not.

Environmental accounts shall provide policy-makers and the public with:

1. indicators and descriptive statistics to monitor of the interaction between the environment and the economy,

2. and with an accompanying database for strategic planning and policy analysis to identify more sustainable development paths, and policy instruments for achieving these paths.

It can be said, that there exist in principle *two* different approaches to account for the environment. On the one hand, certain economists (see, for instance Hueting (1974, 1980), Mäler (1991), Hartwick (1990), Harrison (1989) et cetera) propose to adjust the Net National Income (NNI) for the value of environmental damages to generate a green national income. On the other hand, other economists, mostly national accountants (see, for instance Keuning (1991), de Haan (2004), Keuning & Steenge (1999), et cetera) only want to relate the economic performance of an economy to environmental damages measured in physical units. The main difference between both approaches is that the supporters of the GNI propose to monetarize environmental damages, where the opponents of such an approach only want to develop a hybrid accounting system.[15] This scientific discussion had taken place on an international level (OECD, World Bank, EU, national statistical bureaus, London group[16]) and at the same time within the Netherlands. That means that the Netherlands regarding that problem could be interpreted as a kind of mirror image which represents not only development of environmental accounts within the Netherlands, but also the development in the rest of the world.

Of course, the number of different definitions of a GNI seems endless, but in principle all these different concepts try to subtract environmental damages measured in monetary units from the conventional National Income, only the way how to value environmental damages is different.[17] In some sense the approach of the Dutch economist Roefie Hueting (1974, 1980) seems to be representative for all other similar approaches of a GNI. To my knowledge Hueting was the first one who developed an idea of an environmental accounting system. Other Dutch economists developed the idea of a hybrid accounting system, which they called National Accounting Matrix including Environmental Accounts (NAMEA). The leading researcher was Stephen Keuning. He and his colleagues developed an accounting matrix, where they relate economic indicators (measured in monetary units) to environmental indicators (measured in physical units). Of course also there exist some alternative approaches like material flow accounting, but the NAMEA seems to be superior to alternative approaches.[18] Additionally, because of the fact that there exist many references about

[15] Hybrid system in this sense means a system, where the economic variables are measured in monetary terms and environmental variables are measured in physical units like kg, tons et cetera.

[16] The London is a group of scientists from different statistical bureau, who try to find out which environmental accounting system should be preferred.

[17] See e.g. Aaheim & Nyborg (1995) or Lange (2003) for an overview.

[18] See e.g. Lange (2003) for an overview and explanation of different environmental accounting concepts, including different definitions of a GNI.

sustainability concepts, we shall not consider every approach.[19] The remaining however is the question, what the term *"sustainability"* should mean?[20]

At first the Brundtland Commission Report, *Our Common Future*, popularized the notion of sustainable development as

"...development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

This rather vague concept is related to basic definition of sustainability of economics. The starting point of sustainability was the notion of sustainable income expressed by Hicks (1946):

"...income is the maximum amount an individual can consume during a period and remain as well off at the end of the period as at the beginning."

The sustainable income of Hicks (1946) is interpreted as the amount of income that can be spent without depleting the wealth which generates the income. Hence, sustainability requires non-decreasing levels of capital stock over time, or, at the level of the individual, non-decreasing per capita capital stock.

Indicators of sustainability can be based on either the value of total assets every period, or by the change in wealth, depreciation of capital in the conventional national accounts. Consequently, for a proper measure of sustainability, the following assets should be included in such an indicator:[21]

-manufactured capital,
-natural capital
-human capital.

[19] Pezzey (1989, 1994) gives a review about much more approaches about environmental accounting.

[20] A more detailed analysis of the concepts of sustainability is given by Ayres, van den Bergh & Gowdy (1998), Gowdy (2004) or Heal (1996).

[21] See Lange (2003).

In the last fifty years, only manufactured capital was recorded in the SNA, because up to now there is no uniformly accepted method or agreement to measure and value natural and human capital. [22]

Economic sustainability can be defined as *'strong'* or *'weak'*. These two kinds of sustainability reflect the controversy over the degree of substitution between two different forms of capital.[23]

The concept of weak sustainability requires only that the aggregated value of all assets remains constant. That means that it is possible to substitute one form of capital for another, so natural capital can be depleted or the environment degraded as long as there are compensating investments in other types of capital: manufactured, human, or other type of natural capital. Or in the words of Brekke (1997):

"A development is ...said to be weakly sustainable if the development is non-dimishing from generation to generation. This is by now the dominant interpretation of sustainability."

Common & Perrings (1992) called the concept of weak sustainability *"Hartwick-Solow sustainability"*.[24]

In contrast to *weak* sustainability, the concept of *strong* sustainability requires that each value of a specific form of natural capital must remain constant. The idea behind this strong concept is, that natural capital is a complement to manufactured capital, rather than a substitute. This concept of strong sustainability has direct consequences for environmental policy:

-renewable resources such as fish or forests, can be exploited only at the natural rate of net growth;
-the use of non-renewable resources should be minimized and, ideally, used only at the rate for which renewable substitutes are available;
-emissions of wastes should not exceed the assimilative capacity of the

[22] Until now, human capital has not yet been included in the official national accounts, because there is no agreement about how to measure it. Stauvermann (1997) gives an overview about existing ideas how to measure human capital, and what the critical points of the approaches are.

[23] With the help of the concept of limits of substitution Stern (1997) explains the difference between ecological and environmental economics.

[24] See Hartwick (1977), Solow (1986) and for a discussion of their concept Cairns & Yang (2000). The so-called Hartwick-Solow rule gives advice on how to exploit natural resources in an intertemporal efficient way.

environment.

The consequence of these demands is, that the indicator of strong sustainability requires the availability for all natural capital measurements in physical units.

Contrary to this for example Dasgupta & Mäler (2000) have argued that prices can fully reflect sustainability and the limits to substitution. In this context, Hamilton (2000) has pointed to the restrictive and unlikely conditions that must be fulfilled in order for prices to provide a true measure of sustainability.

However, here we take two representative approaches into account. At first, Hueting's Sustainable National Income (SNI) which estimates what the level of national income would be if the economy met all environmental standards using currently-available technology. Hueting's SNI is the maximum income that can be sustained without technological development (excluding the use of nonrenewable resources). It is not meant to represent what the economy should look like, but rather, to show to policy-makers and the public the distance between the current economy and a sustainable economy.

It is a highly complex undertaking in order to calculate a sustainable national income. It requires economic modeling that includes assumptions about the environmental standards to achieve, the technological means to achieve them, the response to policy instruments, and the usual range of assumptions for an economic model:

-income and price elasticities, impacts on trade, and so on.
-different combinations of these options and assumptions about the future
(technological change, production technologies et cetera).

Because of the fact that the sustainable national income is calculated on basis of such strong assumptions, it should be clear that the results will be quite different. We should also observe the period of time over which sustainable income would be achieved. Because of this complexity, no studies have appeared that produce indicators which are comparable across countries.

In the next two sections we give a more explicit presentation of Hueting's SNI and the NAMEA. We will try to be objective as possible. That means that we will try to give an overview about all pros and cons of both approaches.

In the following chapters, we examine two case studies The first case it is the successful introduction of the NAMEA into the official statistics of the Netherlands and the

second case is the rejection of the introduction of an aggregate indicator like the SNI of Hueting. But before we come to these points, we introduce the ideas of the NAMEA and the SNI. First we introduce the NAMEA, because in any case this is the basic statistics to calculate the SNI.

4 The NAMEA System

Here we want to give a short description of the NAMEA system as in use in the Netherlands. We abstain from explaining the details and how the numbers of the NAMEA are calculated. We only want to give a brief overview about the NAMEA, so that it should be possible to understand, what kind of information the NAMEA can provide for policy-makers.

The NAMEA (National Accounting Matrix including Environmental Accounts) is a statistical information system to combine national accounts and environmental accounts in a single matrix. It is a so-called satellite accounting matrix (SAM), as it is described in the SNA 1993 (Chapter XXI).[25] The conception of the NAMEA system is based on the work of Keuning (1992, 1993) de Haan & Keuning (1996) and de Boo, Bosch, Gorter & Keuning (1991, 1993). The origin of their work is the input-output approach[26] of Leontief (1970).[27]
The NAMEA system contains no economic assumptions; it is only descriptive. It maintains a strict borderline between the economic and the environmental aspects. It is represented in monetary units on the one hand and in physical units on the other hand, that is the reason why it is called a hybrid accounting system.

To get a clear understanding of the interrelationships between the natural environment and the economy, we must use a physical representation. (Otherwise, we are not able to understand these relations.) If the NAMEA system would contain monetary values about environmental problems, two problems would occur. Firstly, the environment must be valued

[25] The original idea behind the SAM's (Satellite Accounting Matrix) was to incorporate concerns of inequality and poverty within the national accounts and input-output tables. An introduction to the SAM approach is given in Keuning & de Ruijter (1988), Pyatt & Thorbecke (1976), Pyatt & Round (1986) and Alarcon, van Heemst, Keuning, de Ruijter & Vos (1991).

[26] Duchin & Steenge (1999) give a technical overview about input-output analysis with respect to environmental problems. Additionally, Duchin (1998) has presented a structural approach of different I-O models. See also Duchin & Lange (1994).

[27] Leontief´s (1970) analysis of the physical economy *"can be regarded as the first prototype NAMEA since both systems are characterized by a hybrid structure including both physical as well monetary data"* (de Haan (2001), p.5).

in monetary units and secondly it is very delicate task to differentiate between prize changes and quantity changes.

Therefore, the resulting indicators are measured in physical units. The interrelationship between the economy and the environment has two perspectives, an economic one and an environmental one. The economic perspective contains the physical requirements in the economic processes, like energy and material and spatial requirements. The environmental perspective puts forward the consequences of these requirements with respect to the availability of the natural environment. Consequently, the optimal allocation of natural resources requires the consideration of both perspectives.

The fundamental idea of the NAMEA is to extend the conventional national accounting matrix with two additional accounts. One additional account is the account for environmental problems like the greenhouse effect or the ozone layer depletion.[28] The selected environmental themes are partly global environmental problems and partly national and local environmental problems. The selected themes are:[29]

1. Greenhouse effect
2. Ozone layer depletion
3. Acidification
4. Eutrophication
5. Waste
6. Waste water
7. Fossil fuels

The second additional account is for environmental substances, like carbon dioxide or sulfur dioxide, where these substances are expressed in physical quantities, like kilogram, tons et cetera. The selected environmental substances are: [30]

1. CO_2
2. N_2O
3. CH_4

[28] The numbers for the environmental themes are aggregated with the help of the IPCC conventions. This means e.g. that one kg of CO_2 emissions equals one global warming potential, one kg of N_2O emissions equals 270 global warming potentials, and one kg of CH_4 equals 11 global warming potentials.

[29] See for example the NAMEA table in Keuning, van Dalen & de Haan (1999, p.18-22).

4. *CFC's* and halons
5. NO_x
6.
7.
8. *P*
9. *N*

The selection of themes and substances follows those environmental themes which were most important in the view of the Netherlands Ministry of Housing, Spatial Planning and the Environment (1989, 1990, 1992, 1993)[31] and with an approval of the Dutch parliament (Tweede Kamer (1996)). The ministry had designed a single indicator each of the environmental themes, by weighing together the emissions that contributed to each theme.[32]

It can be said, that the NAMEA generates consistent summary indicators for those environmental problems, which are considered to be most pressing at the political level.

The NAMEA is centered around a set of tables, which give an overview of relevant relations between the flow accounts and data on environmental changes. De Haan (2001, p. 12) gives a figure about the scope of the NAMEA system:

[30] See e.g. the NAMEA table in Keuning, van Dalen & de Haan (1999, p.18-22).

[31] The pilot NAMEA in 1993 benefited much from the work done on environmental indicators at the Ministry of Housing, Spatial Planning and the Environment (Adriaanse (1993)).

[32] The indicators refer to Adriaanse (1993). An extended explanation about the aggregation of different environmental substances is given in the Annex B of de Haan, Keuning & Bosch (1993). The authors agree with the view that the kind of aggregation can be doubted, because the connections of chemical substances and their implications to a specific environmental theme are not really known in natural science. This problem is ignored in this paper.

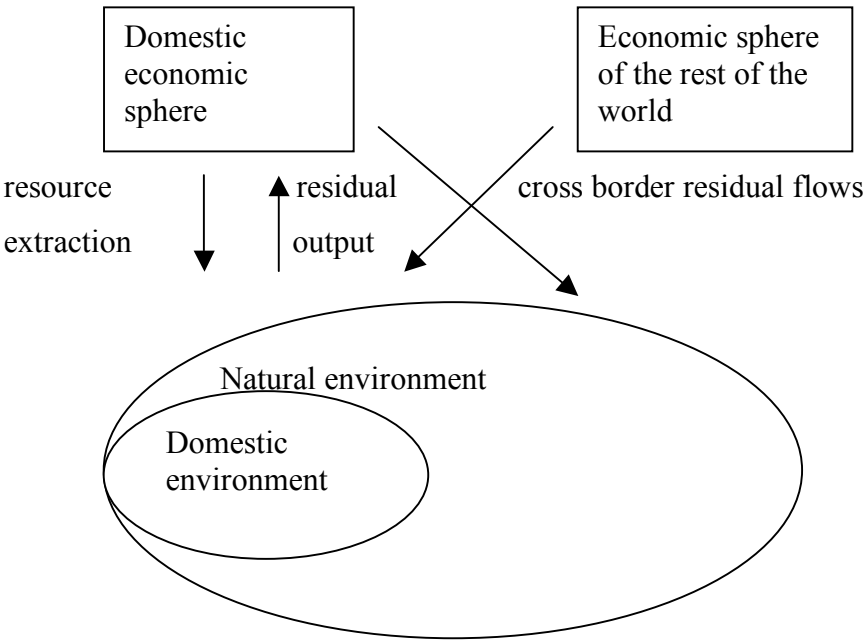

Figure 5

Keuning proposed to put the national accounts in a matrix format to get a coherent, generally applicable system, where specific tables for each relevant substance can easily be related to aggregate ecological and economic flows. As a result, the whole system can be mirrored on a few sheets of paper. Additionally, the matrix format reveals which entities and which accounts are involved at both ends of each set of monetary and physical flows. This especially, is advantageous for the modeling practice.

In the NAMEA system, a strict borderline is maintained between the economy and the environment. For example, the environmental accounts are denominated in different physical units tons, kilo-joules, cubic-meters et cetera, but not in monetary units. In some sense, the NAMEA tables show the boundaries of the core national accounts. The physical accounts of the NAMEA expand these boundaries.

The NAMEA makes the connection between the environment and the economy more clearly and with its help, it is possible to receive a picture where the environmental hot spots are in the national accounts. In addition, it distinguishes between households and industries including public services. These are the main groups of activities. Further, the NAMEA consists of two types of physical accounts: the substances accounts and the environmental themes accounts.

Because the compilation of the NAMEA is explained in Keuning (1992) and Keuning, van Dalen & de Haan (1999) in detail, we refer to that literature.[33]

The NAMEA contains besides the conventional economic aggregates, a summary of environmental indicators. As a result it could be recognized how much a specific economic activity contributes to the GDP, employment, exports et cetera and how much it contributes to the major environmental problems, like the greenhouse effect, ozone layer depletion et cetera. For example, in the Dutch NAMEA 1994 tables it can be seen that the production of electricity in the Netherlands contributes only 1% to employment, but it contributes 25 % to the total emission of CO_2.

Similar observations can be made for each industry to get a profile about each industry. With the help of such profiles it will be become clear that the total pollution of a country does not only depends of the country's size and development stage but also on its structure of economic activities. For example, a country with a relative less developed service sector and high shares of the manufacturing and agrarian sector will relative more pollute the environment than a country where the share of the services sector is relative high.

If NAMEA tables for different periods are available, it is also possible to recognize how the profiles of economic activities changed into time. These aspects are highly relevant to policy-makers and for future estimations.[34]

To give an example de Boer, de Haan & Voogt (1994) make use of a model with the data from the NAMEA to estimate the consequences of reducing the pollution levels to norms set by the Dutch parliament. Verbruggen, Bennis, Dellink, Jansen, Kuik & Ruygrok (1996) make estimations for different scenarios about a sustainable economic development of the Netherlands until 2030.

Without doubt, the results of these model estimates depend on the assumptions about the behavior of the rest of the world and the assumptions about the technical progress to improve Eco-efficiency.[35]

To get some further insights in the possibilities, let us look at the following tables, which are based on the NAMEA 1994 of the Netherlands. For didactical reasons we restrict ourselves to the production sector.

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[33] The NAMEA 1995 is given in appendix of de Haan & Keuning (2000).

[34] But it is necessary to be very careful while interpreting the tables. Stern (2004) for example has shown that it is very questionable if an environmental Kuznets Curve does really exist.

[35] Eco-efficiency is defined as the relation between emissions (measured in physical units) per unit of output (measured in money). See for example Filatova & Stauvermann (2006).

Contribution of Production and consumption to GDP, employment and some environmental themes according to the 1994 NAMEA for the Netherlands

%	Economic indicators		Environmental themes				
	GDP	Employment	Greenhouse effect	Ozone layer depletion	Acidification	Eutrophication	Waste
Agriculture, forestry, fishing	4	5	17	4	46	80	8
Mining, quarrying	3	0	3	-	1	0	1
Manufacturing	18	16	38	40	23	7	44
Public Utilities	2	1	25	0	8	1	2
Construction	6	7	1	27	2	0	25
Transport and storage	8	7	6	3	15	1	6
Environmental cleansing services	0	0	3	21	1	8	1
Other Services	60	63	7	5	4	2	15
Total production	100	100	100	100	100	100	100

Table 1

(Source: van Dalen & de Haan 1999)

This table reflects the relation of different production sectors to different economic indicators (GDP and employment) and environmental themes (greenhouse gas effect, ozone layer depletion, acidification, eutrophication and waste). The total production is normalized to 100. The table tells us how much a specific production sector contributes to the economic indicators and to the environmental themes relative to the aggregate contribution of the aggregate production. For instance, if we look at the third row, we can read how much the agriculture, fishing and forestry sector contributes to GDP in relation to the total output of the production sector. Obviously, 4% of the total output of the production sector is produced in the agrarian sector. Although, the contribution share of the agrarian sector to employment is only 5%, the contribution share to eutrophication is 80 %. To get a better insight into these numbers an additional table can be constructed from the NAMEA.

Cumulative pollution per unit of final demand relative to the aggregate cumulative pollution per unit final demand (1994)

	Economic indicator	Environmental themes				
Emission by producers	Employment	Greenhouse effect	Ozone layer depletion	Acidification	Eutrophication	Waste
Agriculture, forestry	1.77	2.92	1.00	8.32	14.23	1.69
Crude petroleum and natural gas production	0.05	0.54	0.04	0.10	0.02	0.03
Hotels, restaurants	4.40	0.56	0.41	0.53	0.73	0.60
Electricity supply	0.25	4.84	0.08	1.45	0.16	0.29
Construction	2.83	1.87	8.68	1.41	0.36	8.31
Business services	6.49	0.90	1.46	0.66	0.44	1.65
Education	1.84	0.37	0.33	0.17	0.14	0.49

Table 2[36]

(Source: De Haan & Keuning 2000 and Keuning, van Dalen & de Haan 1999)

The numbers in the table give an impression for specific industries of the deviation of cumulated pollution per unit of final demand in relation to the average over all industries. The average pollution per unit of final output is standardized to one. Let us look for example at the construction sector, in last column is the number 8.31. This means that the relative contribution of this sector to waste is 8.31 times higher than its relative contribution to the GDP.

Given these tables for specific periods, as in de Haan & Keuning (1995) or Keuning & de Haan (1996, 1997), it is possible to decompose the changes in emissions by industry into several effects:[37]

1. Demand composition shift effects
2. Output growth effects

[36] This table consists only of part of the original table.

[37] An explanation how to do this is given in de Haan & Kee (2004) and De Haan (2000).

3. Eco-efficiency change effects

The first effect can be positive or negative in the sense that the claims to use the natural environment are reduced. The second effect is negative, because more output means in general an increased use of the natural environment, because of the laws of thermodynamics. The third effect is positive, because of technological progress. De Haan (1996) for example has connected the NAMEA with data on estimated costs and emissions reductions of a range of potential energy-saving measures by industry in the Netherlands. He came to the conclusion that the Dutch economy would be better off to some extend, if the most efficiency measures are applied first. However, if the norms for CO_2 emissions set by the government were too restrictive the result would be the reverse.

In principle, the NAMEA system has much in common with the SEEA 2003 system. Both systems are similar with respect to the use of a matrix format, to the kind how environmental protection expenditures are treated and how to deal and incorporate social issues. However, there exist some differences:[38]

1. The SEEA 2003 focuses on an extension of the standard asset accounts with accounts for environmental assets like rivers, sea, air et cetera. Contrary to this the NAMEA begins with an extension to the complete national accounting system with environmental substances accounts and environmental themes accounts.

2. The NAMEA does not contain a SNI, or a Green National Income, or an Eco-Domestic Product, as the SEEA 2003 does.[39]

3. The NAMEA system aggregates pollutants by environmental problems, but the SEEA system does not contain such an aggregation.

4. The NAMEA system can be used for analytical applications based on a Leontief model. For example, with the help of the NAMEA system it is possible to estimate the total pollution which is generated by one unit of final demand for each product group. (E.g., the electricity supply contributes 4.84 more to the green house effect per unit of

[38] See e.g. Keuning & Steenge (1999) and especially Kee & De Haan (2004) explain the differences between SEEA and the NAMEA approach.

[39] Later we will come back to this.

final demand than the average product group of the economy, see the previous table.) Such type of accounting is not included in the SEEA system.

5. The methodology of the present version of the SEEA is, to view the degradation of natural resources in the same way as the consumption of fixed capital in national accounts. This is not the case in the NAMEA system.[40]

It can be conclude, that the NAMEA is a multi-purpose information system, which is able to inform the public and policy-makers about the status quo of the environmental assets and environmental pollution. Especially, the NAMEA provides policy-makers with a data-framework, which can be used to sketch the trade-off between prevention of environmental damages and macro-economic policy objectives.

It is no problem to extend the NAMEA system with additional environmental themes and substances. The selection which kind of environmental problems should be represented depends on the political decisions and not on the decisions of scientists. This is the reason, why the NAMEA's of different countries are different. (The British NAMEA contains 15 environmental substances and only 3 environmental themes (Vaze 1999), the Japanese one contains 16 substances and 6 themes (Ike 1999), the German one contains 8 substances and 2 themes (Tjahjadi, Schaefer, Radermacher & Hoeh 1999) and the Swedish NAMEA contains 5 substances (Hellsten, Ribacke & Wickbom 1999).[41] Without any doubt, it would be useful to standardize the NAMEA's of all Countries, because of the global environmental problems.

The data from the NAMEA can be used for calculating, e.g. the effects of a shift in tax incidence, from labor to energy use, say, on environmental and economic indicators in the NAMEA system. Additionally, the data can be used for modeling a general equilibrium model to estimate the consequences of a change in the tax system.

With the help of the NAMEA, it is possible to calculate the consequences of specific political decisions. For example, let us look at the introduction of catalytic converters into cars. As a consequence, the burden of the ozone layer depletion decreased by nearly 12.3 % in the Netherlands. Further, it is no problem to integrate social accounts into the NAMEA system. This is done in the so-called System of Economic and Social Accounting Matrices

[40] Reasoning for this is given later on.

[41] For a comparison of the different approaches, see de Haan (1999).

Extensions (SESAME).[42] In addition, it is possible to get new insights for the question who should pay for the environmental damages.[43]

At least it can be said that the NAMEA is a tool or an instrument to account for environmental problems and it combines the data from the environment with the economic data from the core of the SNA. However, no specific economic assumptions are used to compile a NAMEA. Policy-makers are free to decide which kinds of environmental themes and environmental substances should be regarded and policy-makers must decide how they want to resolve the environmental problems. As a result, the NAMEA does not only serve to derive aggregate indicators from a consistent meso-level information system, it also provides data in the required format for all kinds of analyses.

5 The Sustainable National Income of Roefie Hueting

The Dutch economist Roefie Hueting has been writing on economics and the environment since at least 1969. In 1974, his thesis *"New Scarcity and Economic Growth"*[44] was published under his promoter Jan Pen. Hueting was the founder of the Department of Environmental Statistics at the CBS. He was an employee of the CBS from 1969 until 1994. For the most part of his scientific life, he has written about sustainable national income.

In the view of Hueting, the System of National Accounts (SNA) should be extended with respect to environmental losses. This should be done because otherwise some important welfare losses of an economy are ignored. This is the main thesis of his whole work.[45] Especially, he calls for an introduction of a *practical concept of sustainability* into the national accounting system.

Hueting's contributions concern the relationship of the indicators for the Net National Income (NNI) and the Sustainable National Income (SNI). It is important to see that Hueting's work is founded theoretically, and applied to economic statistics. His objective is to provide adequate information to the users of statistical data about the state of the natural environment.

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[42] See e.g. Keuning (1997), Keuning (1998), Van de Ven, Kazemier & Keuning (1999), Keuning & de Haan (1996).

[43] See Steenge (1997, 1999).

[44] An English translation of Hueting's book was published 1980.

[45] He published some 75 articles, papers and books in English about this theme. Goodland (2001, p. 326-331) gives an overview of the work of Hueting.

This section is mainly based on the work of Hueting & de Boer 2001, Hueting & Reijnders (1998), Hueting (1998), (1970, 1974a, 1974b, 1980, 1992, 1995, 1996), and Hueting, Bosch & de Boer (1992, 1995).

Before we come to the details of Hueting's work, it is necessary to recall that national income accounting is founded in social welfare theory, which has been developed by Jan Tinbergen, John Maynard Keynes, Simon Kuznets, John Hicks, James Meade and Richard Stone. The basic idea of Hueting is to compare the economic performance of a specific country in two different periods of time- the length of a time period is mostly one year- and to determine whether welfare has increased or not. Since the Bergson-Samuelson social welfare function[46] (SWF) is not observable, (net-) income per head is used as a proxy for welfare, and observed market prices are used to deflate to real values. In this case, the statistical challenge thus is not income per se, but the *development of welfare*.[47] Observed market prices were used because of the assumption of optimality of market economies. In most cases, it is an acceptable assumption that the current allocation is indeed optimal. However, the natural environment and most of natural resources have no market prices.[48] National income is recorded at observed prices anyway, while separate indicators are provided on the state of the resources.

Hueting proposed the following solution to resolve these problems. In his opinion, it is reasonable, that we (the inhabitants of the world) should prefer the conservation of our natural environment absolutely to reach strong sustainability.[49] This view goes back to Mill's (1876)

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[46] This welfare function goes back to Bergson (1938) and Samuelson (1956). The welfare function W consists of all individual utility functions U_i: $W = W(U_1,...U_n)$, where n is the number of individuals and $U_i = U_i(x_{1i}, x_{2i},...x_{mi})$ represents the individual utility function, where x_{ji} represents the quantity of goods consumed by individual i and m is the number of available goods..

[47] The absolute value of real net income per head is relevant if someone wants to compare the economic performance of countries within the same period.

[48] This is basically caused by the fact that can be interpreted as a public good. In general, the damaging of the natural environment caused by production or consumption is called a negative externality in economics. The reason is that the producer or the consumer takes the damage of the natural environment, which is costless, not into his account.

[49] In the literature (see Goodland (1995) for an overview) exists many different definitions of sustainability: for example weak sustainability, strong sustainability. Hueting defines sustainability as a situation in which vital environmental functions remain available ad infinitum. In Hueting's view his concept of sustainability is scientifically objective. (See Hueting & Reijnders (1998), Reijnders (1996)).

concept of "*steady state*" and "*stationary state*".[50] This implies that it is inadmissible to transfer environmental risks and burdens to future generations. The natural environment must be conserved by the living generation. This consideration is based on the principle of preferences for intergenerational equity.

The idea of Hueting is to calculate the costs for the conservation of the natural environment and to subtract these costs from the NNI. To establish an appropriate maximum environmental burden to meet these preferences, it is in his view seen as a task for natural scientists.

Given his assumptions it follows that the value of environmental degradation is equal to the conservation costs.[51] Additionally, given that these costs are known, it is possible to calculate a SNI. It is the difference between the Net National Income (NNI) minus the aggregated costs to preserve the natural environment from degradation. Or in the words of Hueting & de Boer (2001, p. 19):

"The SNI according to Hueting is the maximum net income which can be sustained on a geological time scale, with future technology progress assumed only in the development of substitutes for non-renewable resources, where such substitution is indispensable for sustaining environmental functions, in turn essential for sustaining income."

In so far Hueting's answer has been to hold on to the classical notion of Hicks (1948). The difference of both incomes then is a measure or indicator for the distance between the current state of the economy and the sustainable economy.[52] The gap between the NNI and SNI measures the dependence of the economy of its natural environment. If the gap is increasing the economy is becoming more unsustainable. If it the gap decreases, the economy is becoming more sustainable.

Additionally, Hueting introduced his concept of 'blockages' to find a way in which statistics can deal with the situation that the individual preferences of the citizens are unknown and that there exists no sufficient mechanism today to find out the true social

[50] Steady state and stationary state means a state, where the per-capita variables such as consumption per-capita, capital per capital et cetera remains constant 'forever'. For details, see Stauvermann (1997).

[51] The costs contain the costs of preserving the environment and the costs of removing existing environmental burden.

[52] In analogy to this is the difference between the actual growth and the optimal growth in the endogenous growth theory. (See e.g. Stauvermann (1997) and the literature there).

preferences.[53] The idea is that sustainability can be defined objectively by natural scientists and could be estimated. The concept of 'blockages' implies that people would accept the standard of sustainability, even if they do not know today[54] (the individuals are 'blocked'). The resulting yardstick thus does not impose preferences, but provides information for the democratic process to be able to decide about actual adoption or not.

The assumptions of Hueting avoid the problem that we must have knowledge about the future. Otherwise, we will run into unsolvable problems.[55]

At the early state of research, Hueting (1974a, 1980) expected that his SNI could be achieved by the use of purely statistical methods. He believed that it would be sufficient to collect data on the opportunities to reduce environmental pollution and environmental resource usage.[56] However, before a SNI can be calculated additional problems must be resolved. The first is how should we account for the environment, if it has different functions for the economy. An example that was given by Hueting (1980, p. 95) is water. Water is a natural resource, without any doubt, but water has different functions. A distinction can be made between the following functions: water for drinking, water for cooling, water for flushing and transport, process water, water for agricultural purposes, water for recreation, water in the natural environment, water for construction and water as a dumping ground for

[53] Arrow (1951) has proved that it is in general not possible to construct a social welfare function, which satisfies five plausible axioms. This is the message of the so-called "Arrow's impossibility theorem". See e.g. Stiglitz (1988). The problem is that the environment is for the most part a public good. Until now there exists no mechanism to reveal the true preferences of individuals for the environment. If the individuals are asked for their preferences they have an incentive to play down their preferences. The argument behind down playing the willingness to pay is that the individual contribution of an individual has only a marginal positive effect on the environment, and the individuals assume that their contribution is insignificant. Because of the fact that all individuals are thinking in the same way, the result is that the contributions and observable preferences for the environment are necessarily played down. Of course in sum this has a negative effect.

[54] A possible reason is that most of the environment or the environmental functions are public goods. Then it is not possible to reveal the true preferences of the people, because there is no mechanism to reveal the true preferences of the members of the economy. The main problem to reveal the true preferences is the so-called prisoner's dilemma. (See for an game-theoretic foundation, e.g. Rasmussen (1989) or Fudenberg & Tirole (1996) and the cited literature there.)

[55] E.g. the models of Weitzman (1976) and of Hartwick (1977), which was based on Solow (1974), are based on very strong assumptions: identical consumer preferences, certain future, no technical change, constant time preferences of the consumers and no distortionary taxes or subsidies. The results of these models break down, if we relax these assumptions.

[56] Later on, we will see that it is not so much easy to calculate the SNI, without additional assumptions.

waste.[57] Undoubtedly, there exists a competition between the different functions, because the functions are scarce. Because of this, the different functions can be interpreted as economic goods.

The concept of an environmental function was also introduced by Hueting (1970, 1974b, 1992). Briefly, environmental functions are defined as possible uses of humanity's biophysical surroundings: water, air, soil, natural resources, plants, and animals. (Hueting & Reijnders (1998, p. 143)). Then sustainability in the sense of Hueting can be defined as the use of environmental functions in a way that they remain available forever. Because of the fact, that all functions should be conserved forever the value of a stock of environmental goods depends on the function, which is most scarce.[58] To make this thought more transparent, think of water as an environmental good. To make the idea clear, let us assume that water has only two functions: drinking water and water as a dumping ground for waste (waste water). The value of the function water depends then on the function of drinking water, because it is possible to use water, which is not suitable for drinking as wastewater. The quantity of drinking water is less than the quantity of wastewater. Insofar the value of the function water depends on the costs, which are necessary to conserve the quantity of drinking water ad infinitum. If we know the cost function for conserving the scarcest function of an environmental good, we get the *supply curve* of the environmental function.

The following figure shall explain Hueting's ideas about the demand and supply side for an environmental function.

[57] It should be noted that the functions could be subdivided. For e.g. recreational water can be subdivided into water for swimming, fishing, boating, skating and waterside recreation.

[58] . In mathematical terms, the scarcest environmental function $f_{\min}$ of the environmental good x can be calculated by the following formula: $f_{\min}(x) = \min[g_1(x_1), ..., g_n(x_n)]$, where the function $g_i(x_i)$ determines the availability of a specific environmental function. The variable x_i represents the quantity of the environmental good, which is available for the specific function *i*. The total number of different functions is *n*.

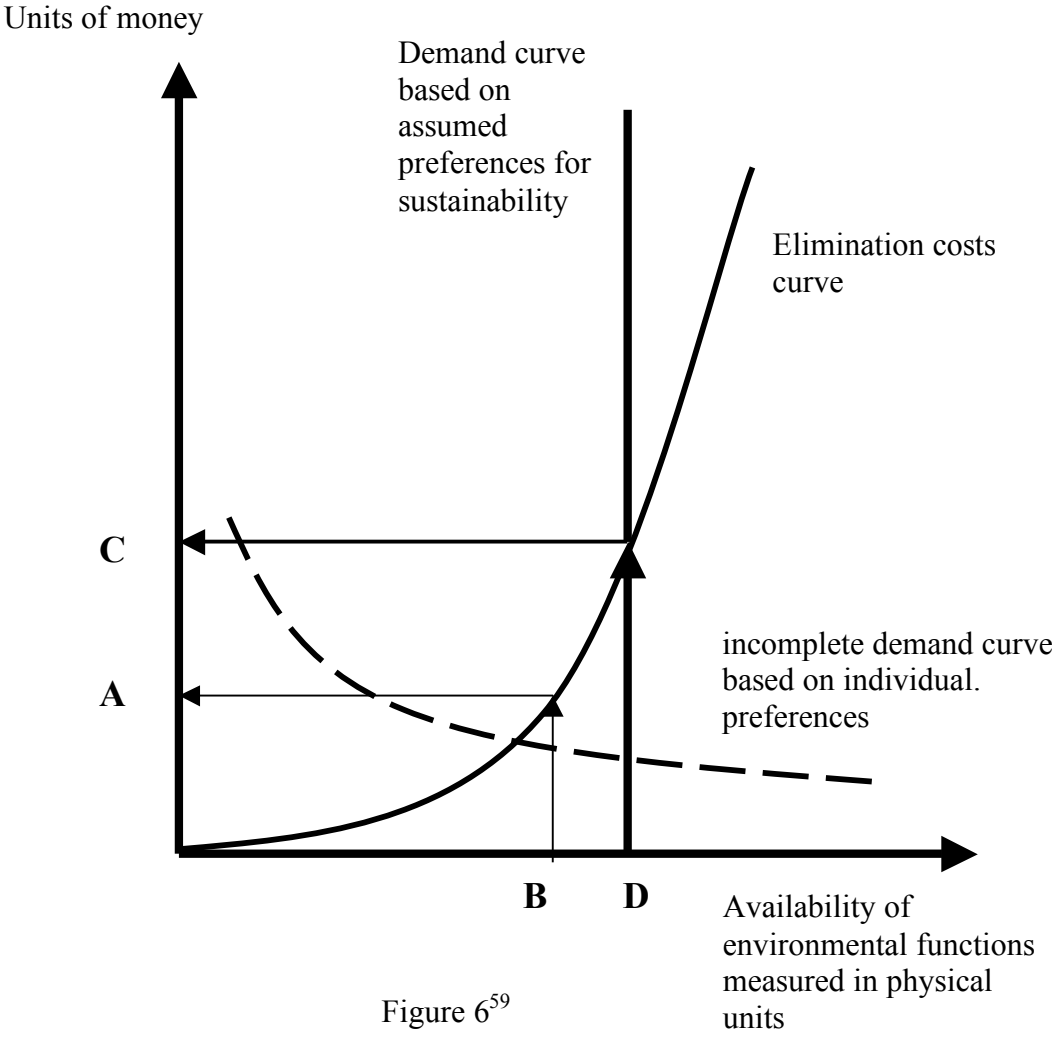

Figure 6[59]

In Figure 6 the point B represents the availability of environmental functions in the present. The point D represents the minimum of environmental functions to preserve the environment from degradation. The dashed line reflects the demand curve derived from individual preferences. The vertical line represents the demand curve derived from the assumed preferences for sustainability. The elimination costs curve can be interpreted as a supply curve of environmental functions. To realize sustainability the society must abstain

[59] An example for the elimination costs curve: think of a specific species. Then it is obvious that a critical level of numbers of individuals must exist to guarantee the survival of this species. If the numbers of individuals fall short of this critical level the species likely will be extincted in the near future.

from consuming BD physical units of environmental functions or expressed in money terms, the society must forego AC units of money.

Given that the elimination cost curves for all environmental goods are known, it is easy to calculate the aggregate elimination costs. This subtracted from the conventional NNI gives the SNI according to Hueting.

The SNI of Hueting was grounded from the beginning on the system of national accounts as a basis for political decision making, and he assesses the SNI already as a welfare index, while other indices often call this system into question. Hueting tries to compare current NNI with his SNI, and he thus excludes problems like income distribution and issues like work at home. The SNI of Hueting is partly similar to alternative measures, but none of the latter ones has all properties as Hueting's SNI.

Overall, there remains a distinct difference between the different indicators. Let us summarize the main properties of the SNI of Hueting:[60]

I. Hueting is engaged in statistics, a backward-looking science. This is also true for his SNI.

II. Hueting remains within the conventional methods of national accounting, especially the SNA. However, Hueting introduces a new figure of national income, the SNI.

III. Hueting's estimation of the SNI is based on four assumptions:

1. The concept of welfare is conventional. This means that, if there exists a strong preference to conserve the natural environment, conservation measures will decrease the NNI and will increase welfare.
2. The concept of environmental functions, where each function must be interpreted an economic good.
2. It is an assumption that there exists a majority of members of an economy for strong sustainability. Strong sustainability for itself is an objective and scientific concept.
3. To calculate the value of environmental functions, the supply and the demand curves must be known. In principle, it is possible to get data about the supply curve, which determined by the elimination costs. The problem is the aggregate demand curve. Because it exists no mechanism to reveal the true preferences of the individuals, because of blockages.

[60] See Hueting & de Boer (2001, p 18).

Therefore, assumptions about the preferences must be made. There are different reasons to assume that the objective strong sustainability can be justified. At first, Hueting argues, since the Brundtland report was published, most countries have agreed that it is an objective of policy to reach strong sustainability. This is a kind of formal reason, but also there exist two other reasons, which are based on theoretical considerations. At first, if we believe in the preferences of Barro (1974) -that means that parents are behaving fully altruistic regarding the expected circumstances of their children's life-, the existing generations have an interest to realize strong sustainability. Secondly, we could assume that agents are only self-interested and that their utility is only dependent on their relative income. Given these assumptions, the introduction of environmental taxes to reach strong sustainability will never decrease the welfare of a society as long if the distribution of income remains the same.

6 A Comparison

However, there are strong arguments in the literature to reject the SNI as a statistical tool. E.g., if the use of environmental resources should be prevented, the structure of the economy would be very different from the structure of today. It would be an evident mistake to ignore these changes. Consequently, a theoretical model must be used, which takes the whole economy into consideration, to calculate Hueting's SNI. As a result, we get a *hypothetical SNI* and a *hypothetical national income*.[61] To calculate this hypothetical SNI for the Netherlands, Verbruggen, Dellink, Gerlagh, Hofkes & Jansen (2001) made additional assumptions:

-the individual preferences for the sustainable use of the environment are absolute and independent of costs. This implies that the aggregate demand curve for environmental functions is absolute price inelastic.

-the instantaneous realization of sustainability standards and no transition costs. This implies that this interpretation of Hueting is a static one.

-The sustainability standards are applied all over the world to arbitrage effects between different countries.

-labor market effects are ignored; no change of the unemployment rate is assumed.

[61] See for example Verbruggen, Dellink, Gerlagh, Hofkes & Jansen (2001, p. 277): *"We then envisage a hypothetical sustainable economy with a hypothetical SNI".*

-The SNI must be calculated with sustainable relative prices.

-The government does not change its politics in the sustainable economy.

Given these assumptions and some additional ones[62], the authors are able to calculate four variants of an SNI for the Netherlands, depending on the relative world market prices, the changes in exports and imports and the relative prices in the sustainable economy. The authors get the following results for the national income:

Variants	Change of national income in % of the original national income (471.1 billion of guilders)
Constant relative prices on the world market and SNI expressed in old relative prices (1a)	-47 %
Constant relative prices on the world market and SNI expressed in new equilibrium relative prices (1b)	-46 %
Constant shares of imports and exports and SNI expressed in old relative prices (2a)	-64 %
Constant shares of imports and exports and SNI expressed in new equilibrium relative prices (2b)	-62 %

Figure 6

We see there exists not only one SNI, but *four*. The differences in the results are very substantial, especially if we note that 1% means the sum of 4.71 billion guilders, which amounts to approximately 2.3 billion €. The difference between the less expensive case (variant 1b) and the worst case (variant 2a) is approximately 36.8 billion €. The results for the aggregate environmental expenditures differs between 0.13 billion of guilders (variant 2a) and 166.62 billion of guilders (variant 1b).

Hofkes, Gerlagh, Lise & Verbruggen (2002) also estimated the SNI for 1990 and 1995 in two variants. (variant 1: fixed world market prices, variant 2 world market prices change proportionally with the new equilibrium prices). For 1990, the national income of the Netherlands by using the SNI (variant 1) is 34% lower than the original NNI. In the second scenario is the national income 56 % lower. In Gerlagh, Dellink, Hofkes & Verbruggen (2002) the range of the decrease of national income in 1990 is between –47 % and –56 %.

[62] Please note that all cited authors in this section made use of a standard neo-classical production function.

Tinbergen & Hueting (1991) calculate a reduction of the national income of around one half of the national income. Then the remaining question is: "What is the correct SNI?" What do we learn from the estimates is that the calculation of the SNI is only possible with very specific assumptions and specific economic models. Let me give an example.

Gerlagh, Dellink, Hofkes & Verbruggen (2001, 2002), Hofkes, Gerlagh & Linderhof (2004) and Dellink, Gerlagh & Hofkes (2001) combine Hueting's SNI with an AGE (Applied General Equilibrium) model to calculate the SNI for the Netherlands in 1990. To model the natural environment they make use of the Data from Keuning's (1993) NAMEA and from de Boer (2002). They calculate that the NNI will decrease from 3.2% - 4.9%, if the green house as emissions will be decreased just around 50%.[63] However the results of the different scenarios are different, but in principle it can be concluded that about one half of the Dutch GDP is produced unsustainable.

The next point is that it is very risky from the viewpoint of politicians to assume that there will be no technical progress in environmental technologies, which would lower the conservation or reconstructing costs. Especially if we think about predictions from the past about the future resources and the environment. From Thomas Malthus, to Stanley Jevons, to the Club of Rome, predictions of imminent ruin of the humankind are legion, and so far have been proved incorrect. Let us take some examples from Beckerman (2001, p.179 f):

"Countries with expanding industry, rapid population growth ...will be especially hard hit by economic energy scarcities from now on"
-A. Lovins (1974)

"The supply of oil will fall to meet increasing demand before 2000, most probably between 1985 and 1995, even if energy prices are 50 cent above current levels in real terms."
-MIT Workshop (1977)

[63] Please note that if the green house gas emissions would have been reduced by 79%, the NNI will decrease by more than 50%. (See Gerlagh, Dellink, Hofkes & Verbruggen (2002, p. 171)). Tinbergen & Hueting (1991) estimated that the realization of a SNI would mean a reduction of 50% of the World Income. Costanza, d'Arge, de Groot, Farber, S., Grasso, M., Hannon, B., Limburg, Naeem, Neill, Paruelo, Raskin, Sutton & van den Belt (1997) estimated the value of the whole ecological system as between 16 and 54 trillion (10) US-$, with an average of 33 trillion US-$. The world gross product of one year is around 47 trillion US-$. (CIA World Fact book 2002). This means, for example that the value of the ecological system equals the gross product of the whole world.

"The diagnosis of the U.S. energy crisis is quite simple: demand for energy is increasing, while supplies of oil and natural gas are diminishing. Unless the U.S makes a timely adjustment before world oil become very scarce and very expensive in the 1980s, the nation's economic security and the American way of life will be gravely endangered."

-Executive Office of the President, National Energy Program (1977)

" The oil-based societies of the industrial world cannot sustained and cannot be replicated. The huge increase in oil prices since 1972 virtually guarantee that the Third World will never derive most of its energy from petroleum"

-Worldwatch Institute (1979)

"Conservative estimates project a price of $ 80 a barrel (in 1985) even if peace is restored to the Persian Gulf and an uncertain stability maintained"

-National Geographic (1981)

Because of these problems the Scientific Council for Government Policy of the Netherlands (WRR) (2002, p. 19) states:

"The fact that in abstracto there are scientific limiting conditions on behaviour would appear clear enough. ...It is however an entirely different matter to determine in concreto whether those limits have been reached or are possibly already being breached, or whether they will come into effect at a point far beyond the relevant time-horizon for decision-making."

Further on:

"The available knowledge is very much fragmentary in nature and the (dynamic) interactions between various sub-elements of the 'system Earth' go beyond the human capacity for understanding."

Keuning (1992) argues against the SNI as an accounting tool with six important statements. At first, he criticizes how the SNI is measured:

"..., instead of the costs of the damage caused to the environment, the costs of preventing and redeeming this damage are proposed as a yardstick for the use of the environment. This may lead to quite misleading policy-prescriptions: in the case of enormous damage which can be

prevented or restored with little costs, the policy-makers wanting to maximize this indicator is not guided to applying this measure, precisely because it hardly improves 'green income'. Furthermore, restoration costs will change over time because of new techniques differ between countries due specific local circumstances which have nothing to do with the extent of the damage. This implies that the same damage leads to quite different GDP (Gross Domestic Product, P.S.)-adjustments in different periods or countries."

Secondly, Keuning (1992) points to the fact, that the direct costs to maintain environmental functions are sometimes only a part of the total costs. He gives the following example:

"For instance, the direct costs of closing a factory, and employing the production factors in a less polluting but less productive alternative activity, may be only a fraction of the total (discounted) income foregone."

This means that it is unclear how to account this foregone future income in the statistics.

In the view of Keuning the avoidance costs approach of Hueting is sometimes misleading. To make this argument more clear, consider the following table:[64]

Year	NNI (€) and growth rate (%)	Services generated by the environment (€)	Avoidance costs (€)	SNI[65] (€) and growth rate (%)	Keuning's Eco-Domestic Product[66] (€) and growth rate (%)
1	400 €	70 €	-	400 €	470 €
2	408 € **2%**	60 €	6 €	402 € **0.5%**	468 € **-0.4 %**
3	416.16 € **2%**	55 €	15 €	401.16 € **-0.2%**	471.16 € **0.7 %**

Figure 7

[64] The numbers are taken from Keuning (1992).

[65] The SNI is the difference between column 2 and column 4.

[66] Keuning's Eco Domestic Product is the sum of column 2 and column 3.

Figure 7 gives an overview of a hypothetical economy over a period of three years. With the beginning of the second year, the economy is sustainable. We see that the signs of the growth rates are not the same for Hueting´s and Keuning's approach. The sign of the growth rates depends on the approach that is selected. Keuning also mentions that there is a time consistency problem, because the SNI does not take into consideration when the damage of an environmental function will occur. It is easy to see that it makes from the view of policy-maker a big difference if damage will occur next year or in one hundred years. Further on, Keuning points out that it is impossible to find out standards for sustainability only with the help of natural sciences. In his opinion it should be the task of policy to define environmental standards and not the task statisticians and environmental institutes. Otherwise, the SNI prejudges the results of such political processes. In the eyes of Keuning, it is against the methodology of the system of national accounting to subtract the avoidance costs from the NNI, because within the SNI the costs must be mirrored by benefits. Because of this, Keuning concludes that the construction of a SNI is not an accounting exercise but an exercise in model building. Or in his words:

"Replacing the GDP (Gross Domestic Product, P.S.) *by a figure which is an erratic combination of statistic and the outcome of an (implicit) model thus amounts to throwing out the baby with the bath-water."*

We also should note that the views of Hueting and his disciples are criticized from several other directions.

El Serafy (1997, p. 221f) criticizes the concepts of green accounting in general:

"*When current prices are used for* (environmental, P.S) *stock valuation, and changes in stock values are incorporated in the flow accounts, the integrity of the latter is damaged, and very little environmental wisdom will be gained from such procedure, and even less economic insight*."

and further on he (1997, p. 224) argued, that

"...accounting in physical units, or in indices based on physical units, are best for revealing environmental change."

Toman (1998) argued in the same way, because in his view (1998, p. 59):

"*cost-benefit analysis and economic valuation are not informationally rich enough to determine policy choices*."

In the view of de Groot, Wilson & Boumans (2002) the value of the ecological system is more complicated to calculate than it is expressed by Hueting. The authors argue that the ecological system consist of an ecological value, a socio-cultural value and an economic value. Their proposals how to calculate the value of the ecological system differs from the methodology of Hueting. Van Dieren (1995, p. 7) considers the green accounting as "*colonization of the environment by the economy*." Bartelmus (1999, p.4) interprets the SNI and similar indicators in the following way:

"*The purpose may indeed be more to spread funk with numbers- a judgment about the GPI (Genuine Progress Indicator) by the Economist (30th September 1995)-than to lend statistical support to decision making."*

It can be said that the main assumption of Hueting is, that the demand for environmental functions is absolute inelastic. That means that the slope of the demand curve is zero. This has some strong implications for the assumed preferences of the individuals.[67]

1. If the actual quantity of an environmental function is lower than the sustainability standard the (implicit) price of demand is infinite high.[68]
2. If the actual quantity of a environmental function is greater than the sustainability standard the (implicit) price of demand is zero.[69]
4. Only if the actual quantity of an environmental function coincides with the sustainability standard, a price between zero and infinity exists.

To make this more clear look at figure 8.

[67] Please note that the demand curve is derived from the preferences of the individuals.

[68] The same can be applied to someone who is in a desert and is in need of drinking water, because without water he will die.

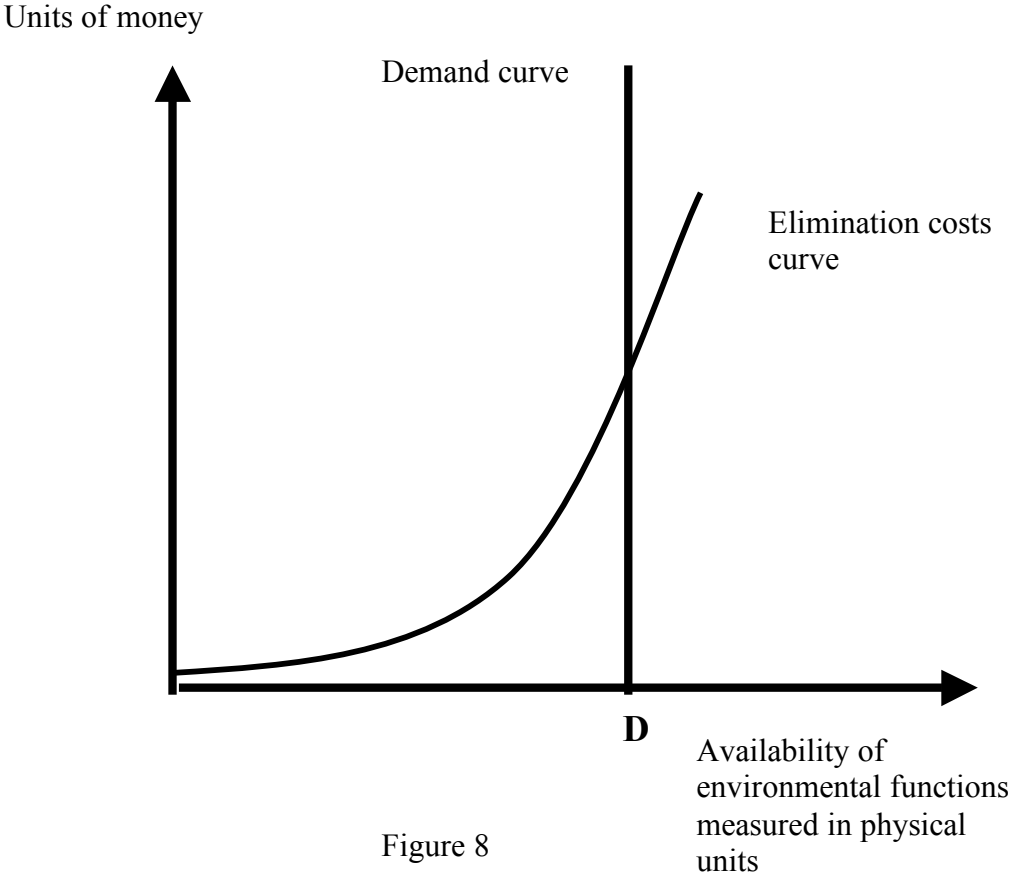

Figure 8

Figure 8 must be interpreted in the following way: If the actual quantity of environmental functions is on the left of point D, the individuals are willing to pay an infinite amount of money to reach the point D. If the quantity is on the right of point D the individuals are not willing to pay anything.

However, the question is: Do such strong preferences for environmental functions exist in the real world, especially if we look at a strange case? Let us assume that the income of a hypothetical country is so low that it is only possible to earn a subsistence minimum. Of course, then we have a real problem, because under such circumstances no one would sacrifice his or her life to realize the sustainability standards. A study of the International Social Science Panels (ISSP) (1993) confirms this view. The result was that in Europe only one third of the inhabitants are willing to pay ecological taxes in order to protect the environment.[70]

[69] This can applied to someone who lives near a river, where it is possible to drink the water without harm. In this case, he is not willing to pay anything for drinking water.

[70] The only exception was the Netherlands, where only 27% of the inhabitants are not willing to pay an ecological tax.

However, if it would not possible to substantiate the sustainability standard of Hueting with preferences, it would be possible to introduce it as a restriction. The resulting question is: from where comes this restriction? The only answer is from deus ex machina, or from an international agreement like the Brundtland-commission.

Also there are some fundamental criticisms from Norgaard, Bode & Values Reading Group (1998) and others, who argue that is impossible to value the environment in monetary units. They ask (title):

"Will ecological economists bring us the value of God next?"

They argue that it makes no sense to value the environment, because a value makes only sense if an exchange is possible with someone. However, the question is with whom we might exchange the environment and what we might be able to do with the money without an environment or earth?

In summary it is clear, that the SNI is a good indicator to inform policy-makers and the public about the status quo of the economy and the environment. Of course, the concept of the SNI does not fit into the SNA from the reasons given above, but nevertheless it is a necessary goal to reach sustainability, because otherwise we must fear that we will harm unborn generations even if the world will not exist forever. All negative critics are more or less based on the assumption that the utility of humans depends only on the quantity of economic goods. But mostly all empirical investigations show that this view is wrong, because the utility of someone depends only on his available income in relation to the income of his neighbor's income. Everybody wants to "keep up with the Joneses ". If someone is living in a wooden house and all his neighbors are living in tents, than the wooden house owner is happy, but if all his neighbors are living in palaces, he feels very bad. Given that view, the SNI is a very acceptable concept for economic modeling, because the model is well-defined and consistent.

7 Conclusions

Now let us summarize what we have learned from the investigation into the NAMEA and SNI approach. At first it should be noted that the NAMEA system is really only a descriptive statistical tool, where no economic assumptions must be made. Because of that it follows, that the NAMEA does not contain an implicit or explicit policy implication.

Maybe, that is the most important argument that we do not find any substantive negative critics on the NAMEA approach in the literature. The NAMEA system can be used by every economic school and in this view it is free of value statements. And of course, a NAMEA is one prerequisite to calculate a SNI. However, it should be noted that we must assume that the NAMEA is to complicate for policy-makers and the public to understand. But the world is complicate.

Contrary, to the NAMEA the SNI approach was rejected as a national accounting tool by many national accountants. The reason is that the SNI is based on a number of critical assumptions. And implicitly, the SNI is based on the ideology of strong sustainability. That means that not policy-makers decide on environmental and implicitly on optimal economic policy, but instead the SNI *forces a specific policy*. Especially, it could be argued in the following way, if the SNI would be accepted as a part of the SNA: feminists could propose that something like an indicator for equal rights for women should be part of the SNA, maybe in the form that all labor must be divided equally between females and males. It seems reasonable to argue that it would be theoretically no problem to calculate an equality NNI indicator. If something like a green GDP is accepted, why should we reject that concept? Or what is, if people would argue we should introduce an indicator for equality of income and wealth? Should this be done?

The answer should be yes. The exercise should be carried out if the public is interested in such numbers, but it should not be published by statistical bureaus, because one important characteristic of the SNA is, that its numbers are not based on ideologies and political ideas. Numbers should be calculated by just other advisory institutions like the CPB. The SNI could be a good information for the public, because we should not assume that the public is able to understand something like the NAMEA but the public will understand the SNI, because it is measured in monetary units.

This conclusion coincides with the decision of the CBS regarding the question how to account for the environment. Nowadays the NAMEA is part of the official statistics of the Netherlands and the SNI was rejected as an accounting tool. The SNI was calculated by the IVM (Free University of Amsterdam) as a political indicator.

In some sense the developments regarding green accounting on the Dutch and international level were very similar. In the Netherlands a commission of economists was founded to decide about the most preferable accounting system. On the international level the London Group, which consists of national accountants from different countries , was selected

to solve the same problem. Both groups came to the result, that it is preferable to adopt the NAMEA instead of a GNI or SNI.

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